Chapter 6: Nonpoint Sources

LESSON GOAL

Demonstrate, through successful completion of the chapter review exercises, a general understanding of the approach for identifying nonpoint sources for inclusion in an emissions inventory; the methodologies for estimating emissions from nonpoint sources; and the reconciliation of fugitive emissions data with ambient data.

STUDENT OBJECTIVES

When you have mastered the material in this chapter, you should be able to:

1. Identify the different sources of data for identifying nonpoint sources for inclusion in an emissions inventory.

2. Explain PM one pagers and identify the information that they contain.

3. Identify typical nonpoint source categories of PM emissions.

4. Describe the general methodology for estimating PM emissions from nonpoint sources.

5. Explain the concepts of rule effectiveness and rule penetration.

6. Explain the mechanisms that lead to the disparity between fugitive emissions data and ambient data.

7. Explain the issues with modeling fugitive dust with both Gaussian and grid models.

Chapter 6: Nonpoint Sources

6.1   OVERVIEW

A nonpoint source is any source that is a stationary source that is not included in the point source inventory. It should be noted that for emission inventory development purposes, EPA has traditionally used the term "area sources" to refer to stationary air pollutant emission sources that are not inventoried at the facility-level. The Consolidated Emissions Reporting Rule (CERR) specifies reporting thresholds for point and area sources of criteria air pollutants, which vary depending on the pollutant and the attainment status of the county in which the source is located (see http://www.epa.gov/ttn/chief/cerr/index.html). The Clean Air Act (CAA) also includes a specific definition of area sources of Hazardous Air Pollutants (HAPs) for the purpose of identifying regulatory applicability. In particular, the CAA defines an area HAP source as "any stationary source . . . that emits or has the potential to emit considering controls, in the aggregate, less than 10 tons per year of any HAP or 25 tons per year of any combination of HAPs." Sources that emit HAPs above these thresholds are categorized as "major sources." To reduce confusion between these two sets of area source definitions, EPA has adopted the term "nonpoint" to refer to all criteria air pollutant and HAP stationary emission sources that are not incorporated into the point source component of the NEI.

Throughout this Chapter there are references to CHIEF, EIIP chapters, EIIP One-pagers, and the PM2.5 Resource Center. Table 6-1 lists the web site address for each of these references.

Table 6-1. Web Address for References Cited in this Chapter

Reference	Web Address
CHIEF	www.epa.gov/ttn/chief
EIIP Chapters	www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html
EIIP One-pagers	www.epa.gov/ttn/chief/eiip/pm25inventory/areasource.html
PM2.5 Resource Center	www.epa.gov/ttn/chief/eiip/pm25inventory/index.html

6.1.1   Identifying Nonpoint Sources

Volume III of the EIIP Area Source Guidance lists the PM fine categories for which the EIIP guidance is available (see Table 6-2). AP-42 and existing emission inventories also can help identify nonpoint source categories that are sources of fine PM and ammonia emissions. Specific existing inventories include the National

Emissions Inventory, the Toxics Release Inventory, and any inventories developed through the efforts of a regional planning organization or state and local agencies.

Table 6-2. Key Chapters of Volume III of the EIIP Area Source Guidance for Sources of PM Emissions

Chapter	Topic
2	Residential Wood Combustion
16	Open Burning
18	Structure Fires
24	Conducting Surveys for Area Source Inventories

The EIIP also has "area source category method abstracts" for charbroiling, vehicle fires, residential and commercial/institutional coal combustion, fuel oil and kerosene combustion, and natural gas and liquefied petroleum gas combustion.

The PM2.5 Resource Center, which is available on the CHIEF website contains "PM one-pagers," which contain an overview of the NEI methods and summarize nonpoint source NEI methods for specific categories of PM_{10}, $PM_{2.5}$, and ammonia. These overviews provide the source category name and SCC, the pollutants of most concern, current NEI method, and how state, locals, and tribal agencies can improve on the NEI method, uncertainties and shortcomings. They also contain activity variables used to calculate the emissions, current variables and assumptions used in the methods, suggestions for improving the variables, and where to find additional information and guidance for the categories. The open burning categories covered by the one-pagers include residential yard waste for leaves, household waste, residential, nonresidential, and road construction land clearing waste, structure fires, wildfires and prescribed burning, and managed or slash burning. Fugitive dust categories covered by the one-pagers include paved and unpaved roads, residential construction, and mining and quarrying. One-pagers also exist for residential combustion (i.e., fireplaces, woodstoves, and other residential home heaters that burn natural gas or fuel oil).

6.1.2   Typical Source Categories

Table 6-3 identifies typical area source categories grouped by fugitive dust sources of filterable PM emissions, open burning nonpoint source categories of carbonaceous fine PM, external and internal fuel combustion nonpoint sources of carbonaceous fine PM, and ammonia nonpoint sources.

Table 6-3. Typical Nonpoint Source Categories

Source Category	Typical Source Categories
Fugitive Dust	Construction Mining and Quarrying Paved and Unpaved Roads Agricultural Tilling Beef Cattle Feed Lots
Open Burning	Open Burning (residential municipal solid waste, yard waste, and land clearing debris) Structure Fires Prescribed Fires Wildfires Agricultural Field Burning
Fuel Combustion	Residential Wood Combustion Other Residential Fuel Combustion Industrial Fuel Combustion Commercial/Institutional Fuel Combustion
Ammonia	Animal Husbandry Agricultural Fertilizer Application Agricultural Fertilizer Manufacturing Waste Water Treatment

Figure 6-1 shows the relative contribution of the nonpoint particulate matter source categories based on the 2001 National Emissions Inventory. Figure 6-2 shows similar data for the ammonia source categories.

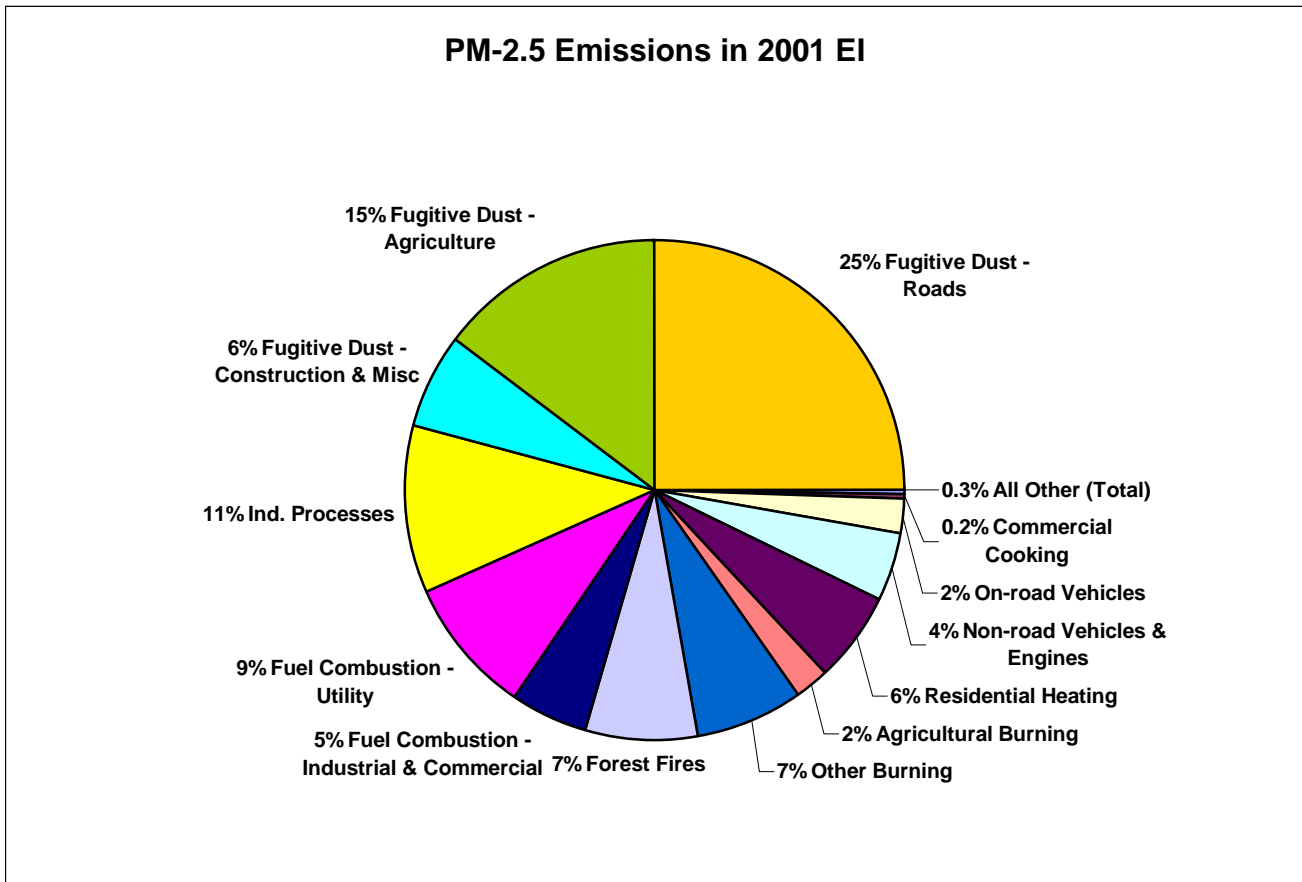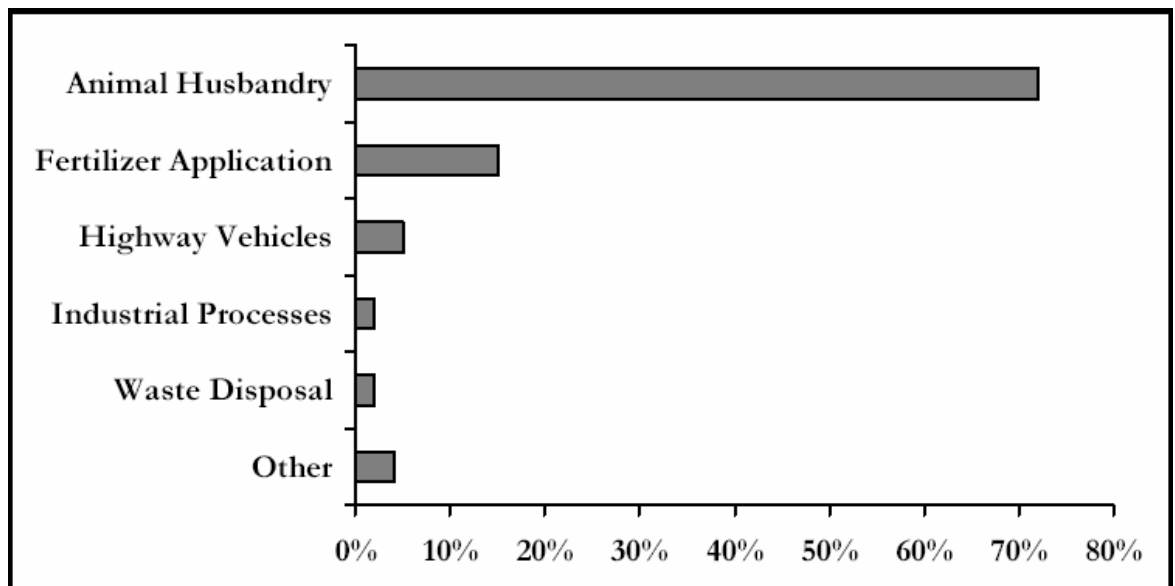**Figure 6-1. PM2.5 Emissions in the 2001 NEI**

PM-2.5 Emissions in 2001 EI

- 15% Fugitive Dust - Agriculture
- 25% Fugitive Dust - Roads
- 6% Fugitive Dust - Construction & Misc
- 0.3% All Other (Total)
- 0.2% Commercial Cooking
- 11% Ind. Processes
- 2% On-road Vehicles
- 4% Non-road Vehicles & Engines
- 9% Fuel Combustion - Utility
- 6% Residential Heating
- 5% Fuel Combustion - Industrial & Commercial
- 2% Agricultural Burning
- 7% Forest Fires
- 7% Other Burning

Figure 6-2. NH3 National Emissions

6.1.3 Estimating Emissions

Nonpoint source inventories are prepared and reported by the 10-digit SCC source classification code. Also, actual emissions, not allowable or potential emissions are reported for the NEI. EPA's master list of SCCs are available on the CHIEF website at www.epa.gov/ttn/chief/codes/index.html#scc. This is a dynamic list that can be updated (with EPA's approval) to add SCCs. For example, SCCs should be added if there are several subcategories within a general nonpoint source category and a state or local agency is estimating emissions at that level.

Emissions from nonpoint sources are calculated by multiplying the activity data with the emission factor, control efficiency data, rule effectiveness, and rule penetration. It should be noted that EPA guidance specifically excludes applying default RE/RP assumption values for PM inventories.   It is highly recommended that the EIIP methods be followed since these were developed with state and local input and they reflect the most current standardized procedures for preparing emission inventories. The EIIP provides preferred and alternative methods for collecting activity data and the use of emission factors, and contains suggested improvements on existing inventory methods.   Equation 6-1 is a summary of the emission estimation equation.

Equation 6-1. Nonpoint Source Emission Estimation Equation

$$C_A = (EF_A)*(Q)*[(1-(CE))(RP)(RE)]$$

where: C_A = Controlled nonpoint source emissions of pollutant A
EF_A = Uncontrolled emission factor for pollutant A
Q = Category activity
CE = % Control efficiency/100
RP = % Rule penetration/100
RE = % Rule effectivenss/100

Activity data is obtained from various published sources of data or surveys. However, the use of use national, regional and state level activity data requires allocation to the counties using county-level surrogate indicator data. As a result, the use of a survey is the preferred approach to obtain the local estimates of activity (i.e., a bottom-up approach, rather than a top-down approach).

Emission factors for PM and ammonia can be obtained from FIRE and AP-42. Alternatively, the emission factor ratio or particle size multiplier approach can be used.   This involves calculating the $PM_{2.5}$ emissions from the PM_{10} emissions using the ratio of $PM_{2.5}$ to PM_{10} emission factors in AP-42.   However, the use of state, local, and tribal emission factors are preferred over any other approach because they are always specific.

Control efficiency is the percentage value representing the amount of a source category's emissions that are controlled by a control device, process change,

reformulation, or a management practice. They typically are represented as the weighted average control for a nonpoint source category.

Rule effectiveness (RE) is an adjustment to the control efficiency to account for failures and uncertainties that affect the actual performance of the control method. Rule penetration (RP) represents the percentage of the nonpoint source category that is covered by the applicable regulation or is expected to be complying with the regulation.

6.1.4   Spatial and Temporal Allocation

The available national, regional, or state-level activity data often require allocation to counties or subcounties using surrogate indicators. As such, state, local, and tribal agencies should review emission estimates developed in this manner for representativeness. The available temporal profiles to estimate seasonal, monthly, or daily emissions for specific categories may be limited so states are encouraged to reflect local patterns of activity in their emission inventories. For example, residential home heating emissions from fuel oil combustion can be allocated to the county level by using the number of households in each county in the state.

6.1.5   EI Development Approaches

The approaches that are available to state, local, and tribal agencies for developing an emissions inventory include developing an emissions inventory following the EIIP procedures; comparing the state, local, tribal activity data and assumptions to the NEI defaults and replacing the defaults, as necessary; or using the NEI default estimates.

The triage approach to improving the emissions inventory involves considering the importance of each NEI category and examining the potential impact on air quality, considering emissions, receptor modeling, and other available information. Improvements should be made to those categories that are determined to be important using the suggestions and references provided in this training course. This includes reviewing the available guidance and deciding what approaches are doable in the near term and longer term.

6.2   RECONCILING FUGITIVE DUST EMISSIONS WITH AMBIENT DATA

As discussed in Chapter 1, the main sources of crustal materials are unpaved roads, agricultural tilling, construction, and wind-blown dust. There is a huge disparity between the crustal data in an emissions inventory and the ambient air quality data. The amount of crustal material on the ambient filters is much less than one would

expect given the large estimates of fugitive dust emissions in the NEI. This apparent anomaly is explained by the fact that fugitive dust has a low transportable fraction.

The data presented in Figure 6-3 show that $PM_{2.5}$ inventories in the States included in the VISTAS area have fugitive dust in the 20-40% range. The rest of PM in the inventory is from sources that are primarily carbonaceous. Comparing this data with the data presented in Figure 6-4 shows that the ratio of crustal $PM_{2.5}$ emissions to total carbonaceous matter emissions does not match with the ratio of crustal to total carbonaceous $PM_{2.5}$ based on the ambient data.
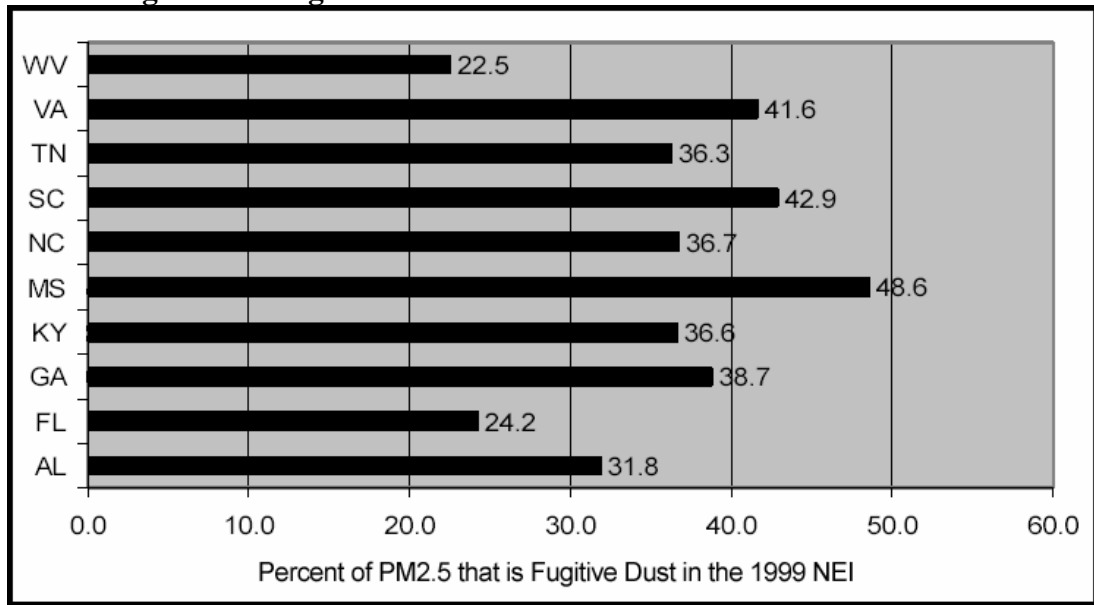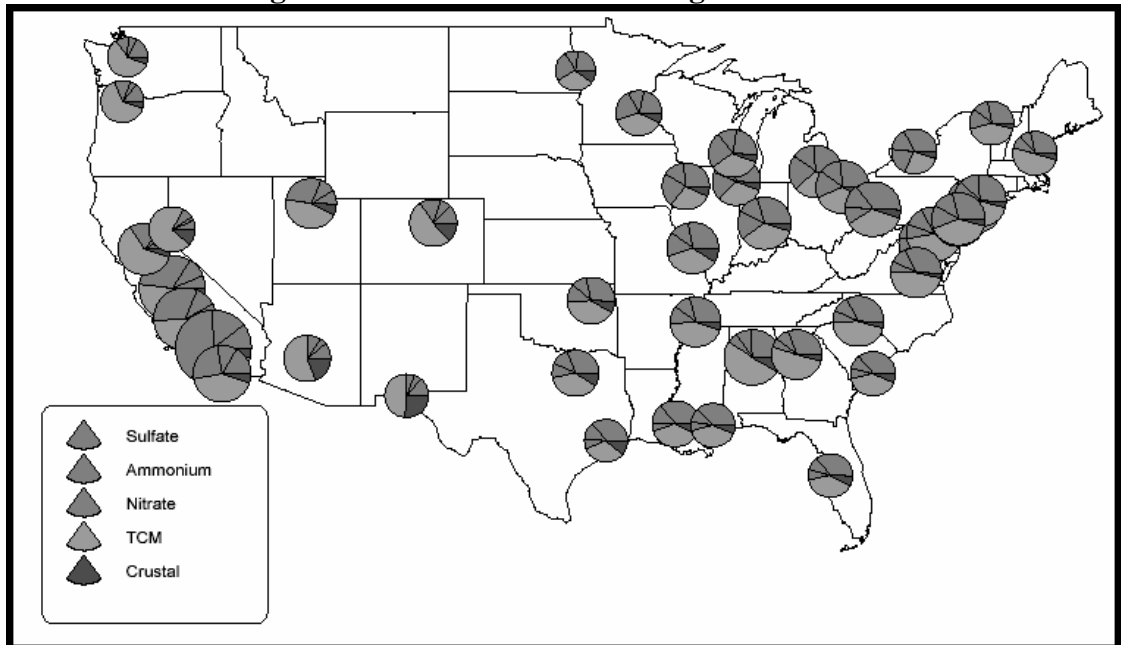
Figure 6-3. Fugitive Dust Emissions in VISTAS States

Figure 6-4. Urban Annual Averages

6.2.1   Fugitive Dust Removal Processes

In the process of developing models the concept of a stilling zone underneath the canopy of vegetation was recognized. Within the stilling zone (the bottom three-fourths of the height of the vegetation) the air is very still and it lends itself to gravitational settling and impaction and filtration by the vegetation.

In the western part of the country it is common to see wind breaks. These are basically a row of trees or other tall vegetation designed to slowdown the wind speed on the leeward side of the downwind side. The overall objective is to prevent the wind from catching the soil and picking it up and eroding it. Another important feature of windbreaks is the entrapment effect involving the transmittance of dust through a wind break. Research shows that the dust that goes through a wind break is about the same as the optical transmittance of light through a wind break and the remainder is trapped in the windbreak.

6.2.2   Capture and Transport Fraction

Capture fraction is the portion of fugitive dust emissions that are removed by nearby surface cover and transport fraction is the portion that is transported out of the source area. The capture fraction plus the transport fraction together sum to the fugitive dust emissions inventory.

Figure 6-5 shows a graph that plots a capture fraction value (from zero to 1) and the type of vegetation qualitatively described as going from densely forested to barren.   The test data plotted on this graph suggest that there is a relationship between the amount of vegetation and the capture fraction. This data suggest that tall leafy dense vegetation has a high capture fraction and the short sparse scattered vegetation has a low capture fraction. This conceptual model has yet to be integrated with air quality models, but it does allow one to assign capture fractions to different types of vegetation as shown in Table 6-4.
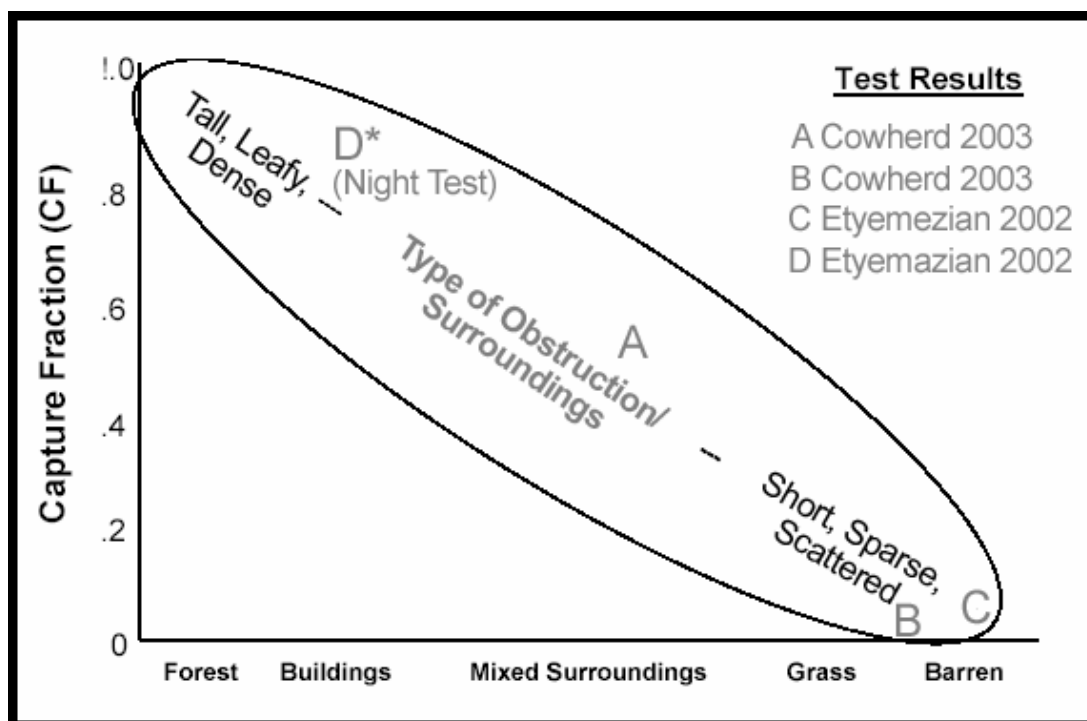
Figure 6-5. Capture Fraction Conceptual Model

Table 6-4. Capture Fraction Estimates

Surface Cover Type	CF (Estimated)
Smooth, Barren or Water	0.03 – 0.1
Agricultural	0.1 – 0.2
Grasses	0.2 – 0.3
Scrub and Sparsely Wooded	0.3 – 0.5
Urban	0.6 – 0.7
Forested	0.9 – 1.0

By using land use databases that contain data on the fractional land use in six different areas (barren and water, agriculture, grass, urban, scrub and sparse vegetation, and forest) it is possible to do a computation of the capture fraction. As shown in Table 6-5, the capture fraction for a given area is the summation of capture fraction by land use type times the county fractional land use amount. The transport fraction is equal to one minus the capture fraction. For example, the transport fraction from the source in Churchill County, Nevada is much higher than the amount that gets away from the source in

Oglethorpe County, Georgia. The main difference is the amount of trees in those two areas. In general, the transport fraction is fairly low in those areas of the country that are very heavily forested, or in cities with a lot of buildings.

Table 6-5. Example Capture Fraction Calculations

Land Use Type	Barren & Water	Agriculture	Grass	Urban	Scrub & Sparse Vegetation	Forest	CF	TF
CF	.03	.15	.2	.6	.3	.95		
Fractional Land Use in Churchill Co., NV	.33	.03	.2.	0	.36	.05	0.23	0.77
Fractional Land Use in Oglethorpe Co., GA	0	.1	.14	0	0	.76	0.76	0.24

6.2.3 Modeling Issues

There are modeling issues associated with using this approach to account for different transport characteristics of dust in different parts of the country. Gaussian models actually have removal mechanisms built in to them to accommodate capture fraction through the use of empirical coefficients. Unfortunately, there is limited data and guidance on how to apply these coefficients, so they are rarely used.

Grid models on the other hand are not equipped to handle particle transport.   One issue with grid models is that they tend to remix particles within the lowest layer during each time step and this results in an underestimation of the removal by gravitational settling. Within a time step of the model particles have had a chance to settle down, but not settle out. In the next time step they are remixed into the whole lower mixing cell, so they may never get out. Also, in the initial grid (i.e., grids no smaller than 4 km square) removal processes, even gravitational settling, are ignored. This is a very significant omission unless the grid is very small. However, modeling very small grids is not really practical.

6.2.4 Summary

Transport fractions should not be used to reduce the emission inventory nor with Gaussian models. They can be used with grid models with the proper caveats. Because there are other issues with the inventory, there will not be instantaneous agreement between the fugitive dust emissions and the ambient data. For example, there are issues with applying the unpaved road factors properly. The transport fraction concept is evolving and over time grid model modifications could eliminate the need for this approach.

Crustal material is a relatively small part of $PM_{2.5}$ in the ambient air. Fugitive dust is released near the ground and surface features often capture the dust near its source. Finally, the capture/transport fraction concept provides a useful way to account for near source removal when used with grid models. This area of research offers many opportunities to improve model performance.

Review Exercises

1. Which of the following is a source for obtaining information for identifying nonpoint sources for inclusion in an emissions inventory?
    a. EIIP Area Source Guidance
    b. AP-42
    c. Toxics Release Inventory
    d. All of the above

2. Which of the following is **not** found in the PM one-pagers for specific categories of nonpoint sources?
    a. An overview of the NEI methods
    b. National emission estimates
    c. Approaches for improving the NEI results
    d. Activity variables

3. Typical fugitive dust categories of _____ emissions include construction, mining, paved and unpaved roads, agricultural tilling, and beef cattle feed lots.
    a. ammonia
    b. carbonaceous fine PM
    c. filterable PM
    d. All of the above

4. Which type of emissions are reported for PM in the NEI?
    a. Actual
    b. Allowable
    c. Potential
    d. All of the above

5. Which of the following data is used in estimating emissions from nonpoint sources?
    a. control efficiency
    b. rule effectiveness
    c. rule penetration
    d. All of the above

6. _____ represents the percentage of the nonpoint source category that is covered by an applicable regulation.
    a. Rule effectiveness
    b. Control efficiency
    c. Rule penetration
    d. Activity data

7. The area that comprises the bottom three-fourths of the height of vegetation underneath a canopy of vegetation is called the _____ zone.
    a. dropout
    b. inversion
    c. laminar
    d. stilling

8. The _____ fraction is the portion of fugitive dust emissions that are removed by nearby surface cover.
    a. capture
    b. transport
    c. suspended
    d. trapped

9. Transport fractions can be used _____ with the proper caveats.
    a. to reduce the emissions inventory
    b. with Gaussian models
    c. with grid models
    d. All of the above

Review Answers

1. d.   All of the above

2. b.   National emission estimates

3. c.   filterable PM

4. a.   Actual

5. d.   All of the above

6. c.   Rule penetration

7. d.   stilling

8. a.   capture

9. c.   with grid models

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